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ABSTRACT

Physics 30 is a twelfth-grade physics course for students in Alberta, Canada. This document is a final test for the course. Intended for administration during January 1986, it contains 56 multiple-choice questions and four written-response problems. Two-and-one-half hours are allowed for completing the test. No answer key is included since scoring is done by the provincial education department. (ML)

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ED274545

GRADE 12 DIPLOMA EXAMINATION

Physics 30

January 1986

Alberta EDUCATION

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GRADE 12 DIPLOMA EXAMINATION
PHYSICS 30

DESCRIPTION

Time: 2½ hours

Total possible marks: 70

This is a **CLOSED-BOOK** examination consisting of two parts:

PART A: 56 multiple-choice questions each with a value of 1 mark.

PART B: Four written-response questions for a total of 14 marks.

A physics data booklet is provided for your reference. Approved calculators may be used.

GENERAL INSTRUCTIONS

Fill in the information on the answer sheet as directed by the examiner.

For multiple-choice questions, read each carefully and decide which of the choices BEST completes the statement or answers the question. Locate that question number on the answer sheet and fill in the space that corresponds to your choice. USE AN HB PENCIL ONLY.

Example

This examination is for the subject area of

A. Chemistry
B. Biology
C. Physics
D. Mathematics

Answer Sheet

A	B	C	D
①	②	●	④

If you wish to change an answer, please erase your first mark completely.

For written-response questions, read each carefully, show all your calculations, and write your answer in the space provided in the examination booklet.

NOTE: The perforated pages at the back of this booklet may be torn out and used for your rough work.

DO NOT FOLD EITHER THE ANSWER SHEET OR THE EXAMINATION BOOKLET

The presiding examiner will collect the answer sheet and examination booklet for transmission to Alberta Education.

JANUARY 1986

PART A

INSTRUCTIONS

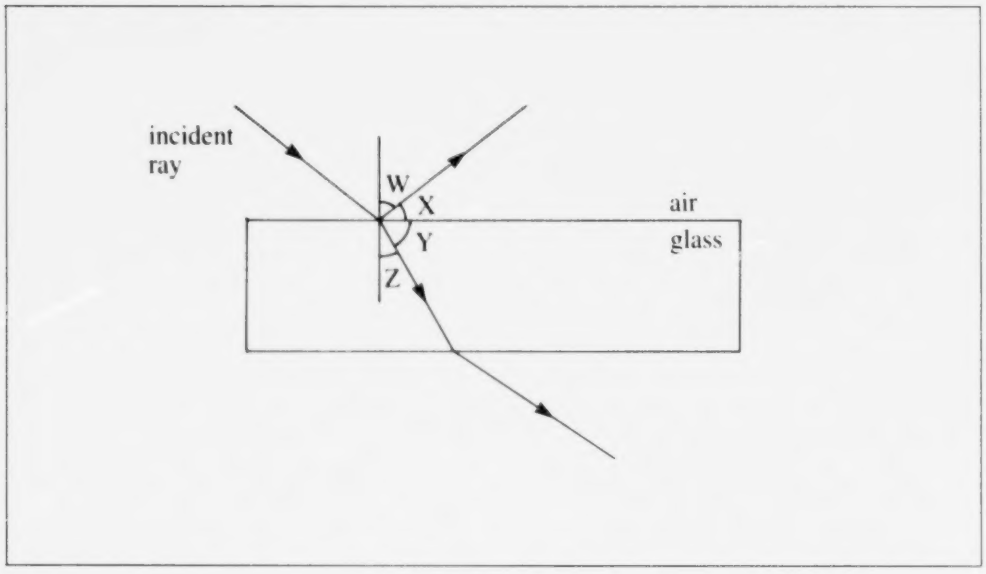
There are 56 multiple-choice questions with a value of one mark each in this section of the examination. Use the separate answer sheet provided and follow the specific instructions given.

NOTE: The perforated pages at the back of this booklet may be torn out and used for your rough work.

WHEN YOU HAVE COMPLETED PART A, PROCEED DIRECTLY TO PART B

DO NOT TURN THE PAGE TO START THE EXAMINATION UNTIL TOLD TO DO SO BY THE PRESIDING EXAMINER.

Use the following information to answer question 1.



1. The angle of refraction is

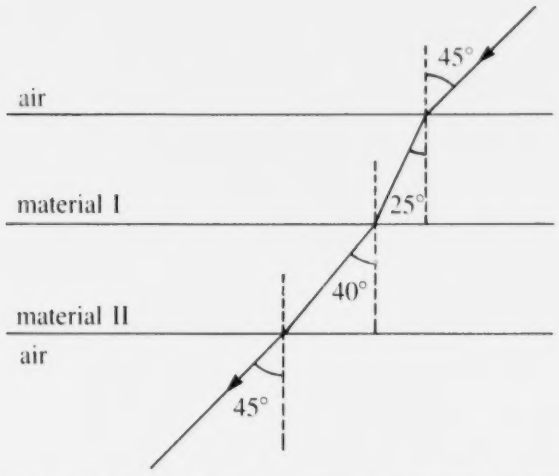
A. W
B. X
C. Y
D. Z

---

2. A laser beam is transmitted to a satellite and back. If the time of travel there and back is 1.23×10^{-2} s, the distance between the satellite and the surface of the Earth is

A. 7.39×10^{7} m
B. 3.69×10^{6} m
C. 1.85×10^{6} m
D. 1.20×10^{6} m

Use the following information to answer question 3.



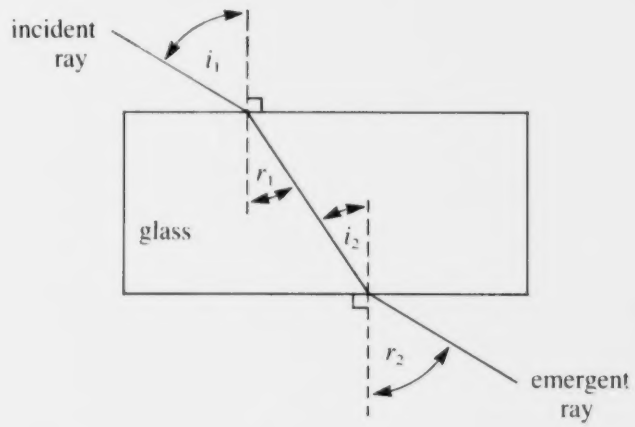
A ray of light passes through two different transparent materials as shown. The faces of the materials are planar and parallel.

3. The speed of light in material I, compared to that in air and material II, is

A. less than in air and less than in material II
B. greater than in air but less than in material II
C. less than in air but greater than in material II
D. greater than in air and greater than in material II

Use the following information to answer question 4.

A student passed a ray of light from air through a rectangular glass prism, and obtained the observations shown below.



From these observations, the student formed the following interpretations:

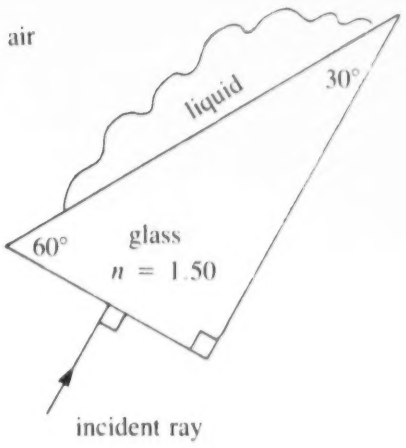
I The incident ray and the emergent ray are parallel.
II The ray passing from air to glass is refracted toward the normal.
III The ray passing from the glass is refracted away from the normal.
IV Angles of refraction are always smaller than angles of incidence.
V The incident ray and the emergent ray lie on the same straight line.

4. Which of the student's interpretations are valid?

A. I, II, III
B. I, II, IV
C. I, III, V
D. II, IV, V

Use the following information to answer question 5.

Liquid Resting on a Triangular Glass Prism



5. The maximum index of refraction of the liquid so that total internal reflection will occur is

A. 0.750
B. 1.30
C. 1.73
D. 3.00

---

6. When a light beam is split into two waves and the crest from one wave meets a trough from the other wave, the waves would be

A. in phase and produce destructive interference
B. in phase and produce constructive interference
C. out of phase and produce destructive interference
D. out of phase and produce constructive interference

7. The overlapping of two waves will result in constructive interference if they meet

A. out of phase
B. sinusoidally
C. crest to trough
D. trough to trough

8. A beam of monochromatic light passes through two slits, producing an interference pattern. For the distance between adjacent fringes to be doubled, the slit separation must be

A. quartered
B. halved
C. doubled
D. quadrupled

9. The period of vibration for light of wavelength 5.0×10^{-7} m is

A. 6.0×10^{14} s
B. 2.0×10^{6} s
C. 2.0×10^{-15} s
D. 1.7×10^{-15} s

10. A polarizing filter is set so that the light passing through it has MAXIMUM brightness. How far must the filter be rotated so that the light passing through it will be of MINIMUM brightness?

A. 360°
B. 180°
C. 135°
D. 90°

11. The phenomenon that demonstrates that light may be considered to be a transverse wave is

A. refraction
B. diffraction
C. polarization
D. interference

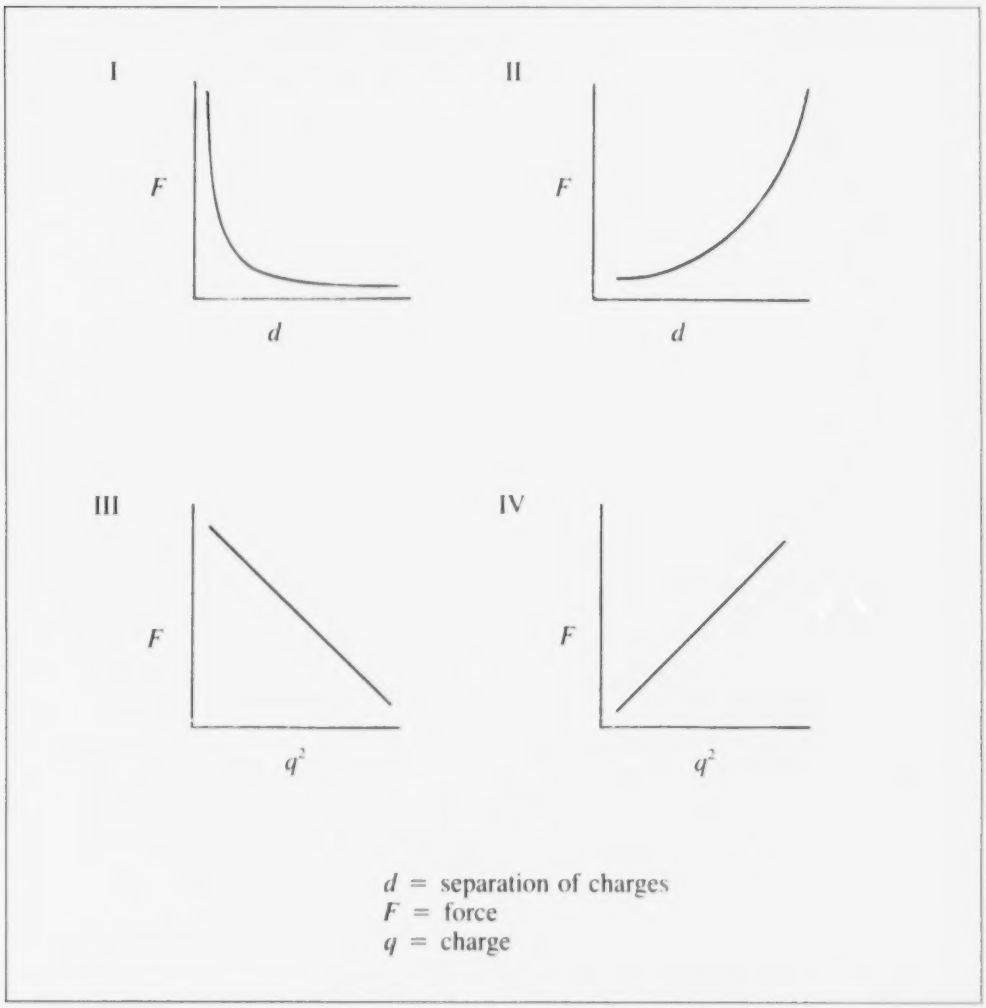
12. To explain both the interference and diffraction of light scientists use

A. a wave model
B. a particle model
C. dispersion phenomena
D. polarization phenomena

13. The wave model of light is deficient because by itself it CANNOT explain the

A. reflection of light
B. diffraction of light
C. polarization of light
D. interaction of light with some atomic particles

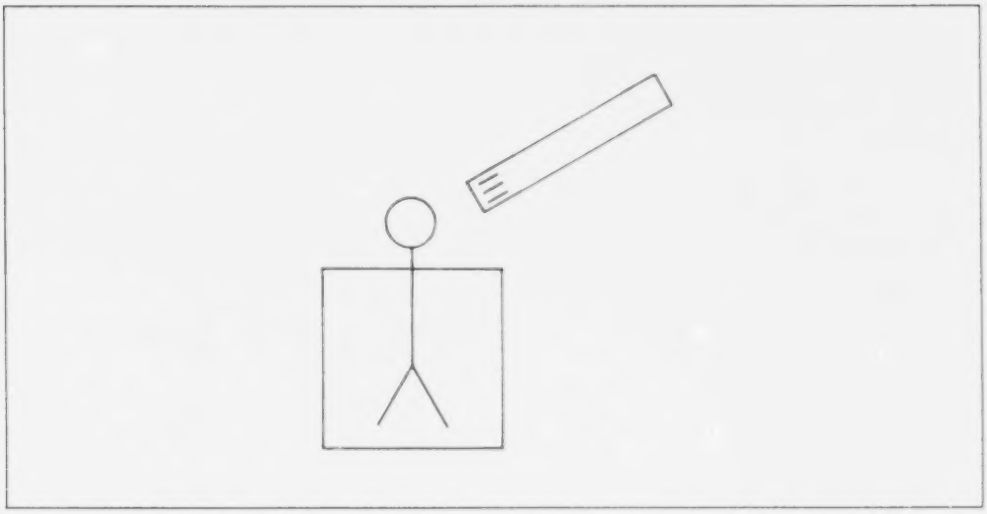
Use the following information to answer question 14.



14. Which graphs illustrate Coulomb's law?

A. I and II
B. I and IV
C. II and III
D. III and IV

Use the following information to answer question 15.



15. When the negatively charged rod is held near the knob on the electroscope, the knob will have

A. a balance of charges
B. a negative charge
C. a positive charge
D. zero charge

---

16. The electrostatic force between two charged objects is 1.0 N. If the charge on each object is doubled and their separation is halved, the new force is

A. 1.0 N
B. 4.0 N
C. 8.0 N
D. 16 N

17. Two very small conducting spheres with equal radii have charges of 3.0×10^{-6} C and -6.0×10^{-6} C respectively. The spheres are touched together and then are separated to a distance of 5.0 cm between their centres. What is the magnitude of the electric force on each sphere?

A. 65 N
B. 8.1 N
C. 6.5×10^{-3} N
D. 8.1×10^{-4} N

18. Which quantity is a scalar?

A. Electric field
B. Magnetic field
C. Intensity of light
D. Velocity of a photon

19. If a flashlight bulb draws 0.20 A from a 1.5 V battery, the power supplied is

A. 0.060 W
B. 0.13 W
C. 0.30 W
D. 7.5 W

20. If a flashlight bulb of resistance 12 Ω is connected to a 6 V battery, the power supplied is

A. 3 J/s
B. 3 J/C
C. 12 J/s
D. 12 J/C

21. The electron volt is a unit of

A. power
B. energy
C. charge
D. potential difference

22. A negatively charged particle with an initial velocity of zero ($v_0 = 0$) is placed in a uniform electric field. If no other forces are present, the particle subsequently will

A. lose charge
B. lose momentum
C. gain kinetic energy
D. gain potential energy

23. The magnitude of the deflecting force on a moving electrically charged particle is affected by the

A. sign of the charge
B. mass of the particle
C. component of the velocity parallel to the magnetic field
D. component of the velocity perpendicular to the magnetic field

24. A particle experiences a deflecting force of 2.5×10^{-6} N as it passes perpendicularly across a magnetic field of strength 0.050 T. If the particle has a charge of 8.0×10^{-4} C, its speed is

A. 1.6×10^{-4} m/s
B. 6.2×10^{-3} m/s
C. 6.2×10^{-2} m/s
D. 1.6×10^{-1} m/s

25. An electric current in a copper wire always produces

A. heat only
B. a magnetic field only
C. heat and a magnetic field
D. heat, light, and a magnetic field

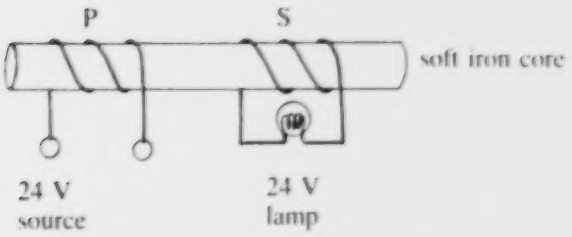
26. The deflecting magnetic force acting on a charged particle moving through a magnetic field depends on

A. speed and charge only
B. speed and strength of the field only
C. charge and strength of the field only
D. charge, speed, and strength of the field

27. Maxwell proposed that a changing magnetic field generates a

A. changing electric field
B. constant electric charge
C. parallel magnetic charge
D. perpendicular magnetic field

Use the following information to answer question 28.



Two insulated wires are wound on the same soft iron core. Coil P can be connected to either a DC or an AC source and coil S is connected to a bulb.

28. Which of the following statements is correct?

A. With an AC source, the lamp does not glow because the wires are insulated.
B. With an AC source, the lamp glows because there is an alternating magnetic field through S.
C. With an AC source, the lamp glows because the current can flow through the core from coil P to coil S.
D. With a DC source, the lamp glows because the current in coil P produces a constant magnetic field in the core.

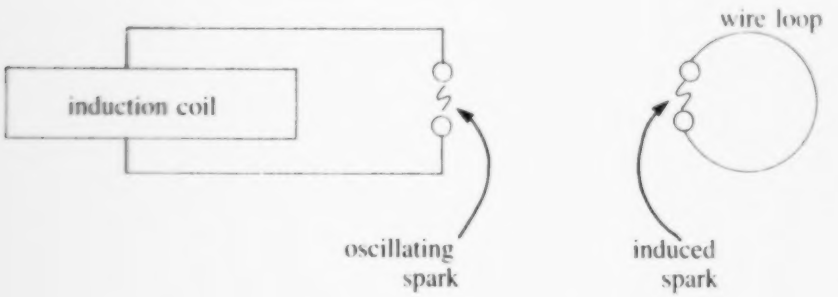
---

29. In a vacuum, all electromagnetic radiation has the same

A. speed
B. amplitude
C. frequency
D. wavelength

Use the following information to answer question 30.

An apparatus similar to that shown in the diagram below can be used to produce and detect electromagnetic waves of about 1 m in length.



30. The experiment that might determine whether the waves produced are polarized is the

A. passage of the waves through slots in a metal sheet
B. placement of a lens-shaped wooden block between the spark gap and the detector loop
C. reflection of the waves from a metal surface to produce a standing wave
D. rotation of the plane of the wire detector loop to a variety of positions

---

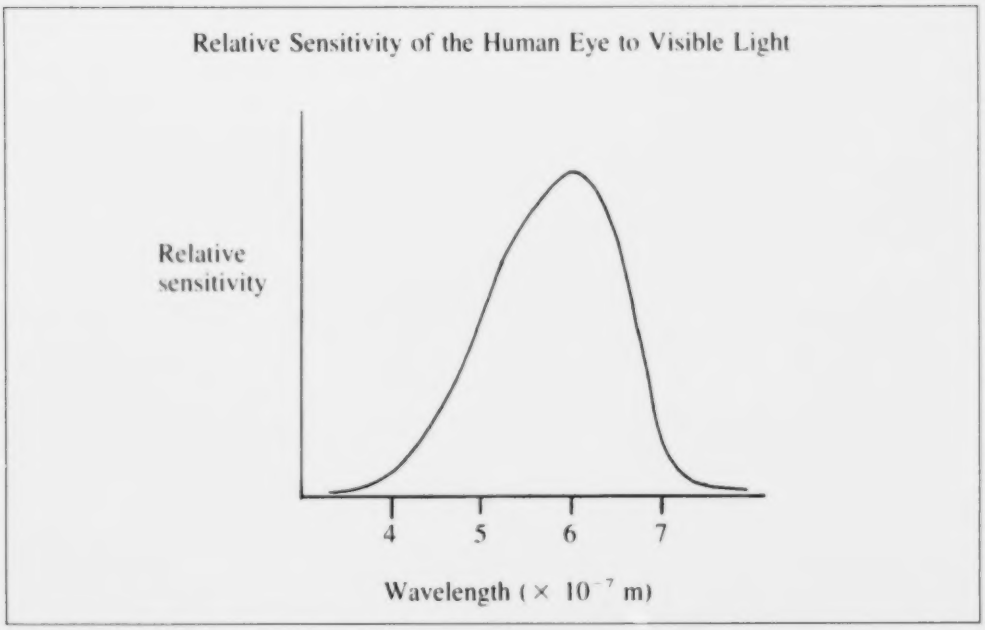
31. Radio-frequency electromagnetic radiation was first produced and detected by

A. Hertz
B. Ampère
C. Faraday
D. Maxwell

32. The frequency of a 4.0 cm wavelength microwave is

A. 1.2×10^{7} Hz
B. 7.5×10^{7} Hz
C. 1.2×10^{9} Hz
D. 7.5×10^{9} Hz

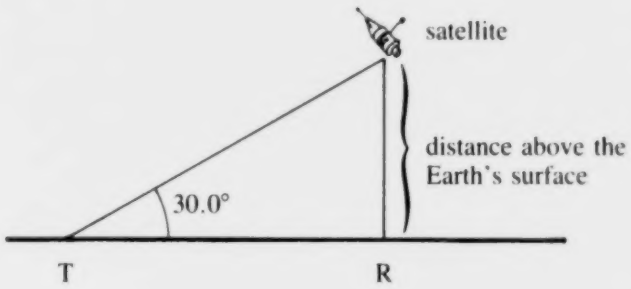
Use the following information to answer question 33.



33. Which statement is valid regarding the relative sensitivity of the human eye to visible light?

A. The human eye is very sensitive to blue light.
B. The red and blue regions of the spectrum are most easily detected by the human eye.
C. The green and yellow regions of the spectrum are most easily detected by the human eye.
D. The human eye is more sensitive to ultraviolet radiation than to infra-red radiation.

Use the following information to answer question 34.



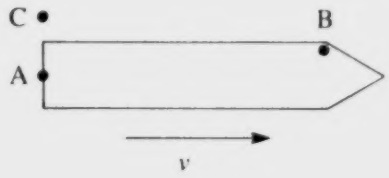
34. Microwave radiation is reflected off a satellite, taking 3.9×10^{-3} s between its transmission from point T and its reception at point T. If the angle of transmission is 30.0°, and the distance between T and R is 5.0×10^{5} m, how far above the surface of the Earth is the satellite? Neglect curvature of the earth.

A. 9.8×10^{5} m
B. 5.9×10^{5} m
C. 3.9×10^{5} m
D. 2.9×10^{5} m

Use the following information to answer question 35.

The diagram represents a space vehicle travelling at $0.8c$ to the right past stationary point C.

A and B are locations in the spaceship. There are light sources at A and C.



35. An experiment performed at location B to measure the speed of light would give the results

A. $0.2c$ for both sources
B. $0.2c$ for source A, $1.0c$ for source C
C. $1.0c$ for source A, $0.2c$ for source C
D. $1.0c$ for both sources

---

36. The postulate of relativity, that light has the same speed for all observers, eliminates the need for the hypothesis that

A. an ether exists through which light travels
B. radio waves are different from X-rays
C. emitted rays have similar velocities
D. light must travel in straight lines

37. Humphry Davy's work is associated with the experimental investigation of

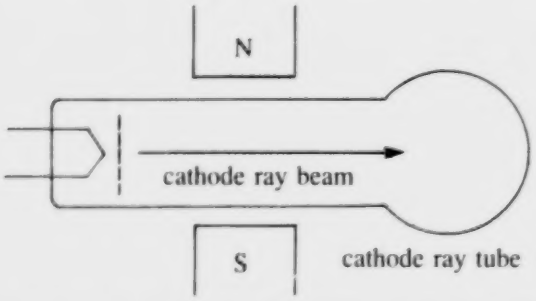
A. the photoelectric effect
B. electromagnetic waves
C. electrolysis
D. X-rays

38. During electrolysis, the mass of aluminum (combining capacity $v = 3$, atomic mass $A = 27$) that would be deposited in 15 min by a current of 0.90 A is

A. 1.2×10^{-1} g
B. 2.3×10^{-1} g
C. 5.4×10^{-2} g
D. 7.6×10^{-2} g

Use the following information to answer question 39.

A Beam of Electrons Travels Through a Magnetic Field



39. The cathode rays are deflected

A. toward S
B. toward N
C. into the page
D. out of the page

Use the following information to answer question 40.

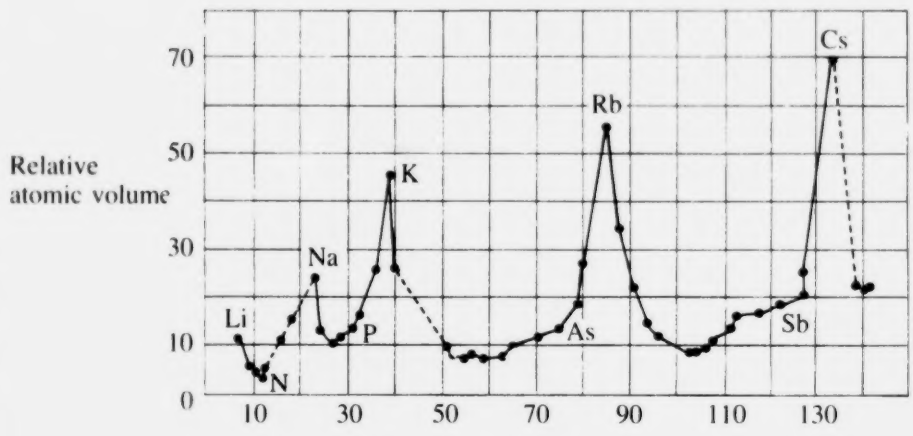
Some properties of cathode rays are listed below.

1. They can travel in a vacuum.
2. They can be bent by magnetic fields.
3. They appear green.
4. They travel in straight lines.
5. They can expose X-ray film badges.
6. They form shadows of large obstacles placed in their path.
7. They can be deflected by charged particles.

40. The FALSE conclusion that cathode rays are a form of light can be drawn from properties

A. 1 and 2
B. 2 and 3
C. 4 and 5
D. 6 and 7

Use the following information to answer question 41.



41. This graph illustrates the law of

A. periodicity
B. combining capacity
C. definite proportions
D. multiple proportions

---

42. Zinc used in a photoelectric cell is illuminated by radiation of frequency 5.6×10^{15} Hz. If the threshold frequency of zinc is 9.7×10^{14} Hz, the maximum kinetic energy of the emitted photoelectrons is

A. 3.7×10^{-18} J
B. 3.0×10^{-18} J
C. 6.4×10^{-19} J
D. 6.6×10^{-34} J

43. If light with a frequency of 1.0×10^{15} Hz causes a metal to emit electrons with kinetic energy of 1.0×10^{-19} J, the work function of the metal is

A. 1.0×10^{-4} J
B. 6.6×10^{-19} J
C. 5.6×10^{-19} J
D. 1.0×10^{-19} J

44. When the photoelectric effect was studied, it was discovered that

A. the frequency of the light has no effect on the current
B. at a particular frequency of light, electrons begin to flow
C. when the light is made brighter, electrons flow more slowly
D. the brightness of the light affects the energy of the electrons

Use the following information to answer questions 45 and 46.

When white light is shone through hydrogen gas, a dark line in the absorption spectrum, corresponding to the red line in the emission spectrum, is observed. This red line is produced by the transition of an electron from the $n = 3$ to the $n = 2$ Bohr orbit.

45. The energy of the absorbed photon is

A. 1.5 eV
B. 1.9 eV
C. 2.2 eV
D. 3.4 eV

46. The frequency of the absorbed red light is

A. 8.2×10^{14} Hz
B. 5.3×10^{14} Hz
C. 4.6×10^{14} Hz
D. 3.6×10^{14} Hz

47. Several gaseous elements and vapors of solid elements are heated. The emitted light is studied with a spectroscope. Which statement is true?

A. The light from each element consists of a broad and continuous range of wavelengths.
B. Vapors of solid elements produce spectra that consist of a continuous range of wavelengths.
C. The light from each element consists of bright spectral lines that are characteristic of the element.
D. Some of the bright lines in the spectrum of an element are exactly the same as those in every other element's spectrum.

48. Both the Bohr model of the atom and the theory of quantum mechanics predict the

A. radius of all electron orbits
B. energy levels of the hydrogen atom
C. relative brightness of various emission lines
D. spectra of atoms with two or more electrons in the outermost shell

49. An observation consistent with relativity theory is that

A. mass, acceleration, and force are invariant quantities for high-speed particles
B. when particles move at speeds exceeding 7.5×10^7 m/s, their mass increases significantly
C. the momentum of high-speed particles is equivalent to the particles' rest mass times their velocity
D. the force required to accelerate particles to high speeds is inversely proportional to the rest mass of the particles

50. The mass change associated with a change of energy of 2.5×10^4 J is

A. 3.6×10^{12} kg
B. 2.5 kg
C. 8.3×10^{-5} kg
D. 2.8×10^{-13} kg

51. The effects of wave-particle duality are too small to measure when applied to

A. planets
B. photons
C. electrons
D. hydrogen ions

52. The mass of a particle which has a wavelength of 5.00×10^{-15} m and a speed of $0.01c$ is

A. 4.42×10^{-26} kg
B. 1.33×10^{-17} kg
C. 2.51×10^{12} kg
D. 2.26×10^{25} kg

53. The theoretical de Broglie wavelength of a 1.0×10^{4} kg automobile travelling at 3.0×10^{1} m/s is

A. 5.0×10^{28} m
B. 3.0×10^{-28} m
C. 2.0×10^{-29} m
D. 2.2×10^{-38} m

54. Consider a situation in which electrons and protons travel at a speed of 3.0×10^{6} m/s $\pm$ 3.0×10^{4} m/s. If the masses of these particles are measured to an accuracy of 10%, then according to the uncertainty principle, the uncertainty in position is

A. greater for the protons
B. greater for the electrons
C. the same for both particles
D. equal to or greater than 10% for both particles

55. A 2.0×10^{2} kg object travelling at $0.500c$ has a relativistic mass of

A. 1.7×10^{2} kg
B. 2.3×10^{2} kg
C. 2.7×10^{2} kg
D. 4.0×10^{2} kg

56. Quantum mechanics can predict the

A. behavior of a particle at a specific time
B. probabilities for the behavior of a particle
C. behavior of each one in a group of particles
D. probabilities for the behavior of waves but not of particles

YOU HAVE NOW COMPLETED THE MULTIPLE-CHOICE SECTION OF THE EXAMINATION. PLEASE PROCEED TO THE NEXT PAGE AND ANSWER THE WRITTEN-RESPONSE QUESTIONS IN PART B.

PART B

INSTRUCTIONS

Please write your answers in the examination booklet as neatly as possible.

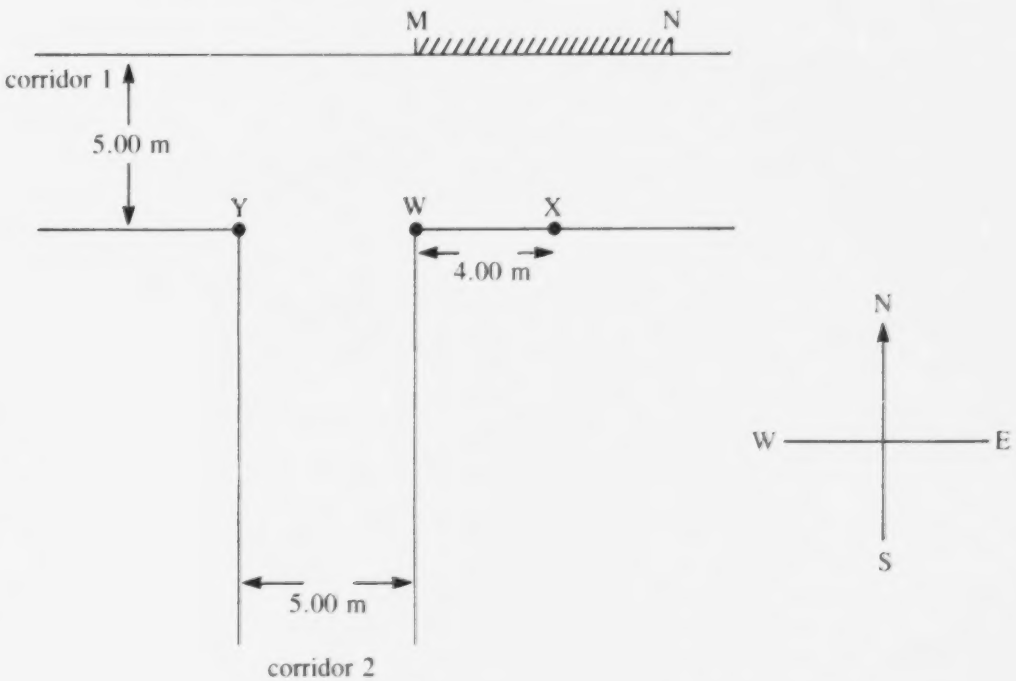
Marks will be awarded for pertinent explanations, calculations, formulas, and answers. Answers must be given to the appropriate number of significant digits.

NOTE: The perforated pages at the back of this booklet may be torn out and used for your rough work.

TOTAL MARKS: 14

START PART B IMMEDIATELY

1. A person stands at position X as indicated in the diagram below. Across from the person is a plane mirror MN.



(1 mark) **a.** Complete the diagram to indicate the farthest point on the line SOUTH of Y that the person can see in the mirror. Label this point Z.

(1 mark) **b.** State the principle that was applied in completing the diagram.

_____

_____

_____

(2 marks) **c.** Determine the distance YZ.

25

2. Using a current balance, a group of physics students conducted an investigation of the interaction between magnetic fields and current-carrying wires.

The following data were collected.

F_m(x 10^{-3} N)	I(A)
1.08	1.50
2.11	3.00
3.21	4.50
4.27	6.00
5.33	7.50

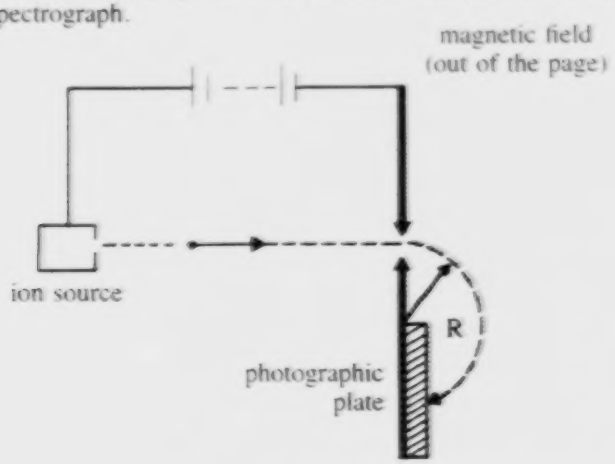
(1 mark) **a.** Based on this data ONLY, what is the relationship between the current and the resulting force exerted by the magnetic field on a current-carrying wire?

_____

(1 mark) **b.** If a current of 8.25 A had been used by the students, what would have been the value of the resulting force?

(2 marks) **c.** The length of the wire used in this experiment was 20.0 cm. Compute the magnetic field strength based on this information. Assume that the wire is perpendicular to the magnetic field.

3. The mass spectrograph is a device that employs principles of electric and magnetic fields to determine the masses of atoms. Charged ions are accelerated by an electric field and enter perpendicularly into a uniform magnetic field. Once in the magnetic field, the ions follow a curved path of radius R. The diagram below illustrates the path of an ion in a mass spectrograph.



(2 marks) **a.** Determine the charge-to-mass ratio of a particle that describes a circular path of radius $R = 0.20$ m when it enters a uniform magnetic field of 0.42 T at a speed of 4.0×10^6 m/s.

(1 mark) **b.** What is the sign of the charge of the ion whose path is shown in the diagram above?

(3 marks) 4. What is the mass of an electron with a kinetic energy of 2.50×10^2 MeV? Be sure to show the formulas that you use to solve this problem.

YOU HAVE NOW COMPLETED THE EXAMINATION. IF YOU HAVE TIME, YOU MAY WISH TO GO BACK AND CHECK YOUR ANSWERS.

TEAR-OUT SHEET

(NO MARKS WILL BE GIVEN FOR WORK DONE ON THIS PAGE)

FOLD AND TEAR ALONG PERFORATION

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M1 M2 M3 M4

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PHYSICS 30

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PHYSICS 30